EIDMANN

Soil Fertility Studies;
St. Clair County, Illinois

Agriculture
B. S.
1903

SOIL FERTILITY STUDIES
WITH SPECIAL REFERENCE TO
TO CERTAIN SOILS OF
ST. CLAIR COUNTY
ILLINOIS

BY

GUSTAVE HERMAN EIDMANN

THESIS

FOR THE DEGREE OF BACHELOR OF
SCIENCE IN THE COLLEGE OF
AGRICULTURE

UNIVERSITY OF ILLINOIS

1903

UNIVERSITY OF ILLINOIS

May 30, 1903

THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

Gustave Herman Eidmann

ENTITLED "Soil Fertility Studies, with Special Reference to Certain Soils of St.Clair County, Illinois"

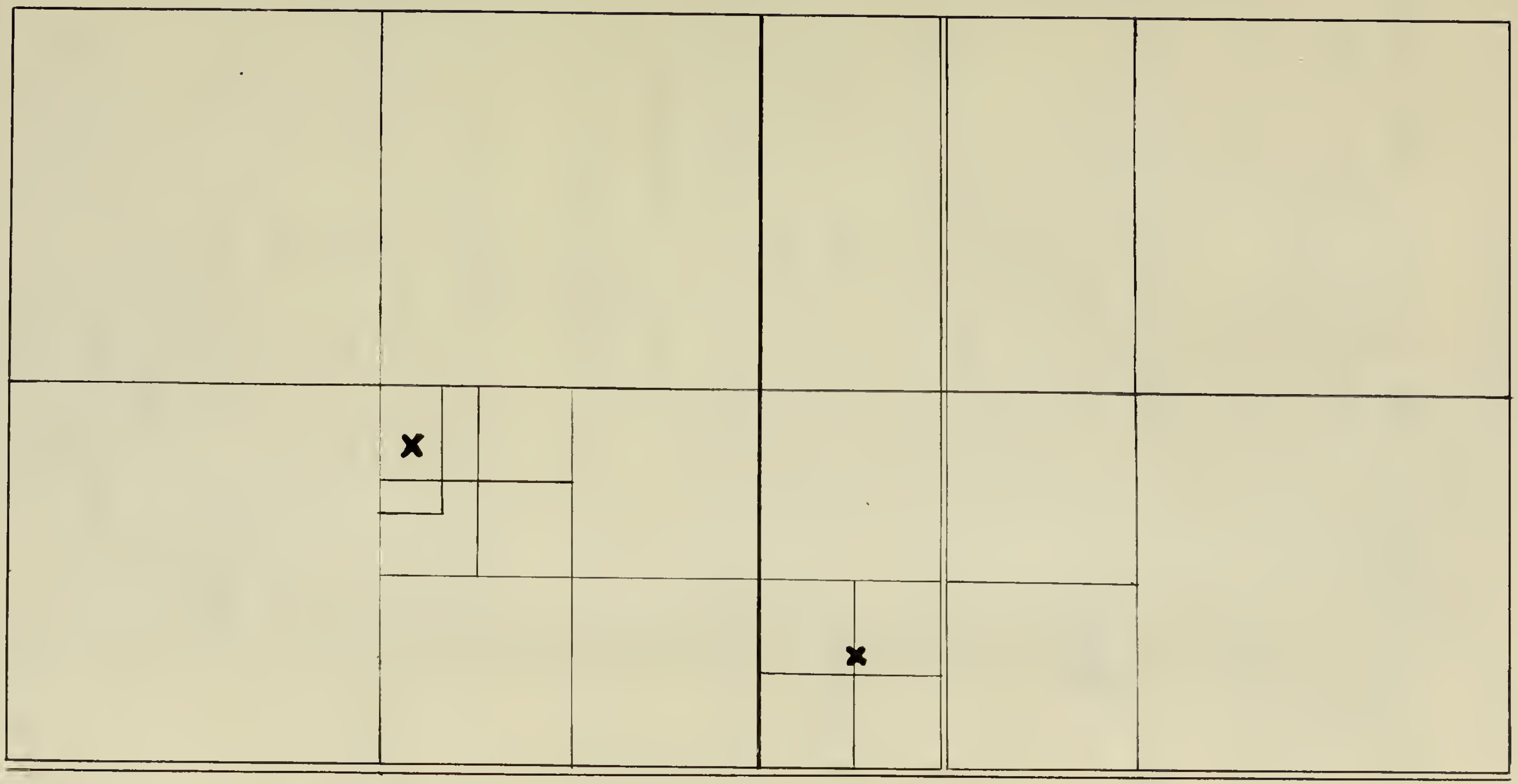
IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE

OF Bachelor of Science in Agriculture

Cyril G. Hopkins

HEAD OF DEPARTMENT OF Agronomy

Engleman Township, St. Clair County, Illinois.



X Places where samples of soil were taken for pot cultures.

INTRODUCTION.

Two series of pot cultures were conducted with each of two types of St. Clair County soils taken from the farm of L. F. Eidmann located in sections seventeen and eighteen of Englemann Township, (Tp. 1 S. R. 6 W. of the third principal meridian).

The object of these investigations was to determine the value of adding lime, nitrogen, phosphorus and potassium to each of these types of soils, for the growing of wheat. The object was later extended and a crop of millet grown after the wheat had been harvested. The first series of pot cultures, which was called the A series was prepared to determine whether or not these elements of fertility when added slightly in excess are of any value to the soils under consideration for the production of the above mentioned crops, while the second or B series was intended to indicate in what amounts it is profitable to add the elements which prove to be of value in series A.

The two soils investigated are so different in physical properties that they were considered as two distinct types. The one type is truly representative of an area of some fifteen to eighteen square miles of level prairie land. The second type lies some ten or fifteen feet lower than the first, lies nearer to the creek, and covers probably no more than two square miles of land. The former is referred to as brown silt loam or upland, and the latter as black clay loam or lowland. Both series A and B of the pot cultures were prepared with each of these types of soil, and the series designated A-U, A-L, B-U or B-L according to the type under consideration,

Series A-[illegible], wheat [illegible] grown [illegible], showing no marked differences between the growth of wheat receiving applications of different elements of fertility.

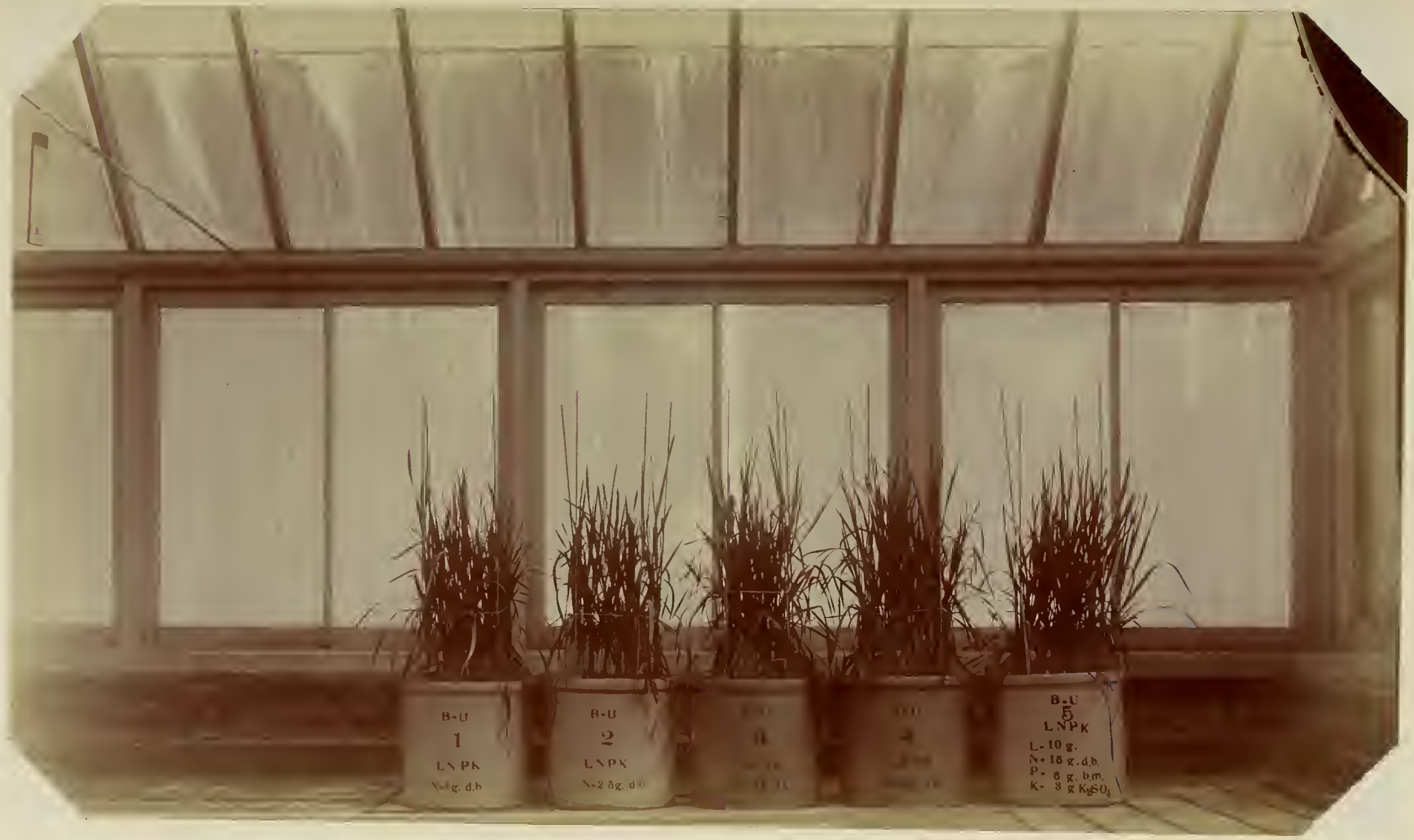
Photographed April 15.

U representing upland and L lowland.

The soils are both prairie soils of the middle Illinoisan glaciation, but have both been considerably modified by a deposit of what seems to be loess, which was probably wind-blown from the bluffs along the Mississippi river, while the lowland type has also been affected by alluvial deposits from surrounding higher lands. In texture these soils are very fine and to a depth of several feet are thought to be loess because they are entirely free from gravel. The upland soil also has a velvety feel which is characteristic of loess, and under ordinary conditions pulverizes very easily.

In color it is considerably lighter than the black prairie silt soils of Central Ilinois, but in mechanical composition it is very similar, being also a silt loam and is therefore called a brown silt loam. The color of the surface soil does not change materially until a depth of eighteen to twenty inches is reached.

In general appearance the lowland type resembles very closely the low, sticky black clay soils of Central Illinois and is therefore called a black clay loam. It is very black in color and begins to grow lighter only at a depth of thirty-four to thirty-six inches. Freezing and thawing pulverizes the exposed surface into cubical granules similar to those of Yazoo clay. This soil is very sticky when wet, and very hard and rough when dry. It is very greatly influenced by its moisture contents. When it contains a certain amount of moisture which does not have a very wide range, it pulverizes very nicely, forming its characteristic cubical granules. Water permeates it very readily. Until about fifty years ago this soil was covered by water the greater part of the time, and only since eight or ten years has surface drainage been affected which removes



Series B-U, nitrogen carrier.- Wheat on Brown silt loam. All pots received like amounts of lime, phosphorus and potassium, but the nitrogen in the form of dried blood was varied as indicated on the pots. Photographed April [illegible].

the surface water fairly well. Even now, since there is no under drainage, water sometimes stands on the field in places until it evaporates. In the immediate vicinity tile drainage has not been attempted on either of these two types of soils.

A short distance to the south, about one third of a mile from where samples of the brown silt loam were taken, is a small moraine about forty five feet higher than section seventeen. The soil on this moraine is coarser in texture, being a fine sandy loam. The rain which falls on a part of this moraine and that which falls on the brown silt loam collects and flows in the direction of the black clay loam to Silver Creek two miles to the west. Water washing over a soil carries with it the fine material leaving the coarser particles behind. Since at one time this water which washed the higher lands stood for days and even weeks upon the lower lying lands, this fine material carried in suspension by the water was deposited by sedimentation and on evaporation of the water, on the lowland, and hence increased the contents of fine material in the lowland soil.

The thickness of the drift in this locality can be estimated from borings made in neighboring towns. To the northwest of this area, at Belleville twelve miles away the bed rock is reached at from 80 to 87 feet; at Renchler six and one half miles away at about 40 feet; to the west six miles, at Freeburg, at from 25 to 30 feet; to the southwest about eight miles at Lementon at 51 feet; to the south about nine miles, at New Athens one boring at 37 feet, while another in the same town at *75 feet; to the northeast about ten and a half miles near New Baden at 27 feet; to the north about

---

*The latter boring is probably in an old abandoned bed of the Kaskaskee river.

Series B-1, Andropogon scoparius,- Grown on brown silt loam. All pots received like amounts of lime, nitrogen and potassium, but the phosphorus in the form of bone meal was varied as indicated on the pots. Photographed April 17.

eleven miles at Summerfield at from 35 to 50 feet; at Lebonan about nine miles to the north on the drift ridge at over 86 feet. The wells in the vicinity where the samples were taken are from 30 to 40 feet deep, and do not reach the bed rock.

Both soils have been cropped for some fifty years. The following shows approximately the system of rotation which has been followed:

Brown Silt Loam		Black Clay Loam	
1893	clover		
1894	corn		
1895	corn	1895	wheat
1896	oats	1896	wheat
1897	wheat	1897	corn
1898	wheat	1898	corn
1899	wheat & clover	1899	corn
1900	clover	1900	corn
1901	corn	1901	oats
1902	corn	1902	timothy

Following is the average yield in bushels per acre of crops grown on the brown silt loam since 1897:

Crops	1897	1898	1899	1900	1901	1902
Wheat	8	18	9	15	23	27
Corn	40	37	40	45	3	55
Oats	24	22.5	20	30	29	36
Timothy	1 T.*	1.5 T.	1 T.	2 T.	1.5 T.	1 T.

* A load of hay from the field was estimated to weigh a ton when cured. T. stands for tons.

Series B-U, potassium sulphate.- Wheat on Upper silt loam. All pots received like amounts of lime, nitrogen and phosphorus, but the potassium in the form of potassium sulfate was varied as indicated on the pots. Photographed April 19.

The yields of the black clay loam are similar to the above. In wheat and oats they are probably somewhat lower, while in corn and hay they are somewhat higher. Corn usually suffers considerably from excessive moisture in the spring. Wheat makes a rank growth producing a large amount of straw, but comparatively little grain. Clover has not been grown upon this soil for eleven years, but when it was grown there, it usually produced a good crop. The writer remembers well when six acres adjoining the nine acre field from which the samples were taken, and which are very similar in type produced an average of three and one third bushels of clover seed per acre after having produced a large crop of hay in the early summer.

Series A-L, wheat on [illegible] crop 1904, showing no marked differences between the growth of wheat receiving applications of different elements of fertility, except where lime was added with and without cotton seed meal - pots 9 and 10. Photographed April 14.

POT CULTURES.

For the pot cultures the sample of upland soil was taken about 15 rods north of the center of the southwest quarter of the southwest quarter of section seventeen. The sample of the lowland soil was taken from the northwest ten acres of the northwest quarter of the southeast quarter of section eighteen. See page 1. The samples were taken one foot deep. In both soils the surface six inches were kept separate from the subsurface. In the upland soil there was also a division of the subsurface at ten inches. This division of the upland subsurface was made because the soil below ten inches was somewhat lighter in color.

In filling the pots the soil was arranged as it lay in the field, that is, the subsurface was put in before the surface. When all the soil had been pulverized and passed through a sieve of one half inch mesh, it was put into the pots as the fertilizer was mixed with it. The fertilizers weighed out for any particular pot were mixed together, and one half of the mixture added to the subsurface and the remaining one half to the surface soil. The lime was added after the pots had been filled with soil, so it was added to the surface four inches.

The lime was added to the pots in the form of ground limestone ($Ca\ CO_3$), the nitrogen, phosphorus and potassium fertilizers in the forms of dried blood, acidulated bone meal and sulfate of potash ($K_2\ SO_4$) respectively. In series A when a fertilizer was added it was always added in the same quantity, a quantity sufficiently large to insure an excessive amount of plant food required for one maximum crop. In series B five* pots constitute a subseries. The

*Pots 8, 7, and 6 are later also compared with the subseries making six pots in each subseries.

Series B-L.- nitrogen [illegible], wheat on black clay loam. All pots received like amounts of lime, phosphorus and potassium, but the nitrogen in the form of dried blood was varied as indicated on the pots. Photographed April [illegible].

lime and two of the three fertilizers are always constant in amounts and always added in excessive quantities, while the third fertilizer is varied from the smallest quantity, which it is practical to add, to one which is quite likely to prove to be too large to be profitable.

In the tables indicating the amounts of fertilizer added to each pot, L in the second column stands for lime, N for nitrogen, P for phosphorus and K for potassium. In the last three columns g. for grams, d. b. for dried blood, and b. m. for bone meal. In the top line printed on the pots the abbreviations U and L stand for upland and lowland respectively.

For the chemical composition of the fertilizers added see appendix, page 50.

The following tables indicate what fertilizers were added, and in what amounts they were added to each pot in the series:

Series B-L.- Phosphorus series, wheat on black clay loam. All pots received like amounts of lime, nitrogen and potassium, but the phosphorus in the form of bone meal was varied as indicated on the pots. Photographed April 1[illegible].

SERIES A-U

Elements of Fertility added in the form of Commercial Fertilizers

No. of pot	Elements added	Lime in grams	Dried blood in grams	Acidulated bone meal in grams	K_2SO_4 in grams
1	None	0	0	0	0
2	L	10	0	0	0
3	LN	10	15	0	0
4	LP	10	0	6	0
5	LK	10	0	0	3
6	LNP	10	15	6	0
7	LNK	10	15	0	3
8	LPK	10	0	6	3
9	LNPK	10	15	6	3
10	NPK	0	15	6	3
11	None	0	0	0	0
12	None	0	0	0	0

Series B-L.- potassium subseries, wheat on black clay loam. All pots received like amounts of lime, nitrogen and phosphorus, but the potassium in the form of potassium sulfate was varied as indicated on the pots. Photographed April 13.

SERIES B-U

Elements of Fertility added in the form of Commercial Fertilizers

No. of pots	Elements added	Lime in grams	Dried blood in grams	Acidulated bone meal in grams	K_2SO_4 in grams
			Nitrogen subseries		
1	LNPK	10	N-1g.d.b.	6	3
2	LNPK	10	N 2.5g.d.b.	6	3
3	LNPK	10	N-5g.d.b.	6	3
4	LNPK	10	N 10g.d.b	6	3
5	LNPK	10	N-15g.d.b.	* P-6g.b.m.	K-3g.K_2SO_4
			Phosphorus subseries		
1	LNPK	10	15	P-.4g.b.m.	3
2	LNPK	10	15	P 1g.b.m.	3
3	LNPK	10	15	P-2g.b.m.	3
4	LNPK	10	15	P-4g.b.m.	3
5	LNPK	10	N-15g.d.b.	P-6g.b.m.	K-3g.K_2SO_4
			Potassium subseries		
1	LNPK	10	15	6	K-.2g.K_2SO_4
2	LNPK	10	15	6	K-.5g.K_2SO_4
3	LNPK	10	15	6	K-1g.K_2SO_4
4	LNPK	10	15	6	K-2g.K_2SO_4
5	LNPK	10	N-15g.d.b.	P 6g.b.m.	K-3g.K_2SO_4

* where an element was added in irregular amounts, it is written in this table in a form identical with that painted on the pots.

Series A-U,- Wheat on brown silt loam, showing a slightly beneficial effect by the application of nitrogen. (Photographed June 30.

SERIES A-L

Elements of Fertility added in the form of Commercial Fertilizers

No. of pot	Elements added	Lime in grams	Dried blood in grams	Acidulated bone meal in grams	K_2SO_4 in grams
1	None	0	0	0	0
2	L	6	0	0	0
3	LN	6	15	0	0
4	LP	6	0	6	0
5	LK	6	0	0	0
6	LNP	6	15	6	0
7	LNK	6	15	0	3
8	LPK	6	0	6	3
9	LNPK	6	15	6	3
10	NPK	0	15	6	3
11	None	0	0	0	0
12	None	0	0	0	0

Series B-U, - nitrogen subseries, wheat on brown silt loam. All pots received like amounts of lime, phosphorus and potassium, but the nitrogen in the form of dried blood was varied as indicated on the pots. Photographed June [illegible].

SERIES B-L

Elements of Fertility added in the form of Commercail Fertilizers

No. of pot	Elements added	Lime in grams	Dried blood in grams	Acidulated bone meal in grams	K_2SO_4 in grams
			Nitrogen subseries		
1	LNPK	6	N-1g.d.b.	6	3
2	LNPK	6	N-2.5g.d.b.	6	3
3	LNPK	6	N-5g.d.b.	6	3
4	LNPK	6	N-10g.d.b.	6	3
5	LNPK	6	N-15g.d.b.	*P-6g.b.m.	K-3g.K_2SO_4
			Phosphorus subseries		
1	LNPK	6	15	P-.4g.b.m.	3
2	LNPK	6	15	P-1g.b.m.	3
3	LNPK	6	15	P-2g.b.m.	3
4	LNPK	6	15	P-4g.b.m.	3
5	LNPK	6	N-15g.d.b.	P-6g.b.m.	K-3g.K_2SO_4
			Potassium subseries		
1	LNPK	6	15	6	K-.2g.K_2SO_4
2	LNPK	6	15	6	K .5g.K_2SO_4
3	LNPK	6	15	6	K-1g.K_2SO_4
4	LNPK	6	15	6	K-2g.K_2SO_4
5	LNPK	6	N-15g.d.b.	P-6g.b.m.	K-3g.K_2SO_4

* Where an element was added in irregular amounts, it is written in this table in a form identical with that painted on the pots.

Series B-U, - Phosphorus sub-series, wheat on brown silt loam. All pots received like amounts of lime, nitrogen and potassium, but the phosphorus in the form of bone meal was varied as indicated on the pots. Photographed June [illegible].

All pots were first seeded, February 2, 1903, to spring wheat, Fife No. 149 from Minnesota Experiment Station. Twenty-five kernels of wheat were planted at equal distances apart in each pot, and on February 26 each pot was thinned to contain ten plants. This crop was harvested on June 23, and the same pots reseeded to millet on July 16. To prepare the pots for the seeding of the millet, no additional lime or fertilizer was added, but the soil was all removed from each pot, keeping the surface from the subsurface and thoroughly pulverized before it was returned to the pots. Each pot was seeded to 25 grains of millet, and later thinned to 15 plants.

At different intervals of the growth of the plants, careful notes were taken on the effect of each kind and quantity of fertilizer used. Photographs were taken of all the pots while growing wheat on April 18 and June 20, and while growing millet on November 4, 1903.

Following are the tables showing the yields which were obtained from both crops:

Series B-U. - Potassium subseries, wheat on brown silt loam. All pots received like amounts of lime, nitrogen and phosphorus, but the potassium in the form of potassium sulfate was varied as indicated on the pots. Photographed June 2[illegible].

SERIES A-U

Yield of Wheat, Grain and Straw, and of Millet Hay

Wheat							Millet
No. of pot	Elements added	No. of heads harvested	No. of heads lost	Weight of straw in grams	Weight of grain in grams	Wt. of grain computed in grams	Wt. of hay* minus heads in grams
1	O	24	0	20.9	11.7	11.7	8.6
2	L	14	14 X	25.6	7.2	14.4 X	10.3
3	LN	32	0	46.1	22.8	22.8	24.0
4	LP	29	1	40.9	13.1	13.7	9.7
5	LK	25	1	32.1	15.0	15.6	10.2
6	LNP	43	0	56.4	23.6	23.6	25.3
7	LNK	34	0	37.6	19.3	19.3	20.5
8	LPK	25	1	34.9	15.6	16.2	8.1
9	LNPK	34	2	49.4	22.7	24.0	25.6
10	NPK	24	3	41.1	17.2	19.3	24.9
11	0	23	0	27.2	11.9	11.9	6.3
12	0	23	0	29.4	13.5	13.5	6.3

X More than twenty percent of the full number of heads lost.

* The heads of the millet were badly mutilated by sparrows, so they were removed and not weighed.

Series A-L,- Wheat on Black clay loam, showing a [illegible] beneficial effect by the the application of nitrogen. Corresponds Page 26.

SERIES A-U

Comparative Value of the Elements of Fertility

	Wheat(grain) in grams	Millet(hay) in grams
Nitrogen		
L &N gain for nitrogen	8.4	13.7
LP &N-gain for nitrogen	9.9	15.6
LK &N-gain for nitrogen	3.7	10.3
LPK&N gain for nitrogen	7.8	17.5
Total gain for nitrogen	29.8	57.1
Average gain for nitrogen	7.5	14.3
Phosphorus		
L &P-gain for phosphorus	4.3	-0.6
LN &P gain for phosphorus	5.8	1.3
LK &P-gain for phosphorus	0.6	-2.1
LNK&P-gain for phosphorus	4.7	5.1
Total gain for phosphorus	15.4	3.7
Average gain for phosphorus	3.9	0.9
Potassium		
L &K-gain for potassium	1.2	-0.1
LN &K-loss for potassium	-3.5	-3.5
LP &K-loss for potassium	-2.5	-1.6
LNP&K-gain for potassium	-4.6	0.3
Total loss for potassium	-9.4	-4.9
Average loss for potassium	-2.4	-1.2

Series B-L,- [illegible] [illegible], grown on black clay loam. All pots received like amounts of lime, phosphorus and potassium, but the nitrogen in the form of dried blood was varied as indicated on the pots. Photographed June [illegible].

SERIES B-U YIELDS

Wheat							Millet
No.of pot	Elements added	No.of heads har-vested	No.of heads lost	Weight of straw in grams	Weight of grain in grams	Wt.of grain computed in grams	Wt.of hay minus heads in grams
			Nitrogen subseries				
8(A-U)*	LPK	25	1	34.9	15.6	16.2	8.1
1	LNPK	30	0	42.6	21.1	21.1	8.9
2	LNPK	26	6	44.9	18.4	22.6	12.9
3	LNPK	34	0	62.6	29.6	29.6	12.4
4	LNPK	28	6	51.6	23.1	28.0	21.3
5	LNPK	34	2	49.4	22.7	24.0	25.6
			Phosphorus subseries				
7(A-U)*	LNK	34	0	37.6	19.3	19.3	20.3
1	LNPK	30	2	46.3	24.3	25.9	21.5
2	LNPK	18	8 X	39.7	13.8	19.9 X	25.5
3	LNPK	30	4	52.3	26.5	30.0	19.7
4	LNPK	6	24 X	42.1	5.3	26.5 X	27.3
5	LNPK	34	2	49.4	22.7	24.0	25.6
			Potassium subseries				
6(A-U)*	LNP	43	0	56.4	25.6	28.6	25.3
1	LNPK	31	2	54.9	23.8	30.6	26.5
2	LNPK	11	19 X	44.2	9.4	25.6 X	22.5
3	LNPK	33	3	57.2	29.5	32.1	21.3
4	LNPK	24	8 X	46.9	20.4	27.2 X	34.0
5	LNPK	34	2	49.4	22.7	24.0	25.6

X More than twenty percent of the full number of heads lost.

* Pots 8,7&6 of series A-U are also employed here because they received the same treatment except in the fertilizers added.

[illegible] I-[illegible], - phosphorus [illegible], wheat on [illegible] clay loam. All pots received like amounts of lime, nitrogen and potassium, but the phosphorus in the form of bone [illegible] was [illegible] as indicated on the [illegible]. [illegible] [illegible] 10.

SERIES A-L

Yield of Wheat, Grain and Straw, and of Millet Hay

Wheat							Millet
No. of pot	Elements added	No. of heads harvested	No. of heads lost	Weight of straw in grams	Weight of grain in grams	Wt. of grain computed in grams	Wt. of hay* minus heads in grams
1	O	30	0	33.8	18.7	18.7	8.1
2	L	30	0	40.5	20.0	20.0	10.7
3	LN	33	0	48.3	25.4	25.4	26.7
4	LP	32	0	42.5	19.2	19.2	11.8
5	LK	29	0	33.9	13.6	13.6	10.0
6	LNP	39	0	51.8	29.1	29.1	31.7
7	LNK	29	0	42.9	23.2	23.2	28.2
8	LPK	32	0	37.7	20.1	20.1	10.0
9	LNPK	37	0	51.6	24.8	24.8	31.7
10	NPK	43	0	63.4	32.5	32.5	17.9
11	O	28	0	57.4	18.5	18.5	12.4
12	O	28	0	36.6	17.1	17.1	9.9

* The heads of the millet were badly mutilated by sparrows, so they were removed and not weighed.

Series B-L.- Potassium series, wheat on black clay loam. All pots received like amounts of lime, nitrogen and phosphorus, but the potassium in the form of potassium sulfate was varied as indicated on the pots. Photographed June 10.

SERIES A-L

Comparitive Value of the Elements of Fertility

	Wheat(grain) in grams	Millet(hay) in grams
Nitrogen		
L &N-gain for nitrogen	5.4	16.0
LP &N-gain for nitrogen	9.9	19.9
LK &N-gain for nitrogen	4.6	18.2
LPK&N-gain for nitrogen	4.7	21.7
Total gain for nitrogen	24.6	75.8
Average gain for nitrogen	6.1	19.0
Phosphorus		
L &P-gain for phosphorus	-0.3	1.1
LN &P gain for phosphorus	3.7	5.0
LK &P-gain for phosphorus	1.3	0.0
LNK&P gain for phosphorus	1.6	3.5
Total gain for phosphorus	6.0	9.6
Average gain for phosphorus	1.5	2.4
Potassium		
L &K loss for potassium	-1.4	-0.7
LN &K-gain for potassium	-2.2	1.5
LP &K-gain for potassium	0.9	-1.8
LNP&K-gain for potassium	0.0	0.0
Total loss for potassium	-2.7	-1.0
Average loss for potassium	-0.7	-0.3

Series A-U, millet on brown silt loam, showing a marked increase of growth in the pots where nitrogen has been added. Photographed November 4.

SERIES B-L YIELDS

Wheat							Millet
No. of pot	Elements added	No. of heads harvested	No. of heads lost	Weight of straw in grams	Weight of grain in grams	Wt. of grain computed in grams	Wt. of hay minus heads in grams
Nitrogen subseries							
5(A-L)*	LPK	32	0	57.7	20.1	20.1	10.0
1	LNPK	26	2	32.6	17.5	18.8	15.0
2	LNPK	32	1	44.7	24.0	24.7	12.9
3	LNPK	27	9 X	46.1	16.6	22.1 X	14.4
4	LNPK	41	0	58.2	31.5	31.5	12.9
5	LNPK	37	0	51.6	24.8	24.8	31.7
Phosphorus subseries							
7(A-L)*	LNK	29	0	42.9	23.2	23.2	28.2
1	LNPK	22	13 X	47.2	6.0	10.9 X	26.5
2	LNPK	33	6	58.3	27.2	28.9	13.0
3	LNPK	13	18 X	44.9	8.6	20.5 X	31.6
4	LNPK	28	8 X	57.6	23.4	30.0 X	31.3
5	LNPK	37	0	51.6	24.8	24.8	31.7
Potassium subseries							
6(A-L)*	LNP	39	0	51.8	29.1	29.1	31.7
1	LNPK	16	21 X	47.1	11.0	25.4 X	33.7
2	LNPK	34	4	57.3	28.3	31.6	20.4
3	LNPK	39	1	70.0	29.1	29.8	25.8
4	LNPK	38	1	59.1	30.0	30.3	26.1
5	LNPK	37	0	51.6	24.8	24.8	31.7

X More than twenty percent of the full number of heads lost.

*Pots 5,7&6 of series A-L are also employed here because they received the same treatment except in the fertilizers added.

Series B-U,- nitrogen subseries, millet in Brown silt loam. All pots received like amounts of all elements except nitrogen which in the form of dried blood was varied as indicated on the pots. Note the increase of growth with the increase of nitrogen. Photographed November 1.

GENERAL CONCLUSIONS.

It should be understood that definite and satisfactory conclusions can not be drawn from the insufficient data which were obtained in these investigations. During the early part of May, the wheat crop became infected with green flies, which could not be kept under absolute control. From the time the wheat began to ripen until it was harvested it was preyed upon by ravagous mice, which infected the pot culture green house. In the absence of the writer, it seemed impossible to control these pests because the pots had to stand very close together, for lack of sufficient green house room. It is very much to the regret of the writer that these obstacles seriously affected the value of the results of the work. It is thought, however, that the suggestions offered by these results can be taken to apply at least in a general way.

There is no means by which the harm done by the fly can be determined. The disastrous work of the mice could be easily seen, but not so readily estimated. In cases where less than twenty percent of the number of heads of wheat were destroyed, the yield can probably be computed with some degree of accuracy, but where the loss was greater than twenty percent, no importance can be attached to the yields of grain which were obtained. It is thought that the mice selected the largest and plumpest rather than the smallest heads and therefore the computed yields are probably too low rather than too high.

When in interpreting the results of the pot cultures, it was found that the difference in yield between two pots, which were to be compared, was less than two grams, this difference was not

Series B -U,- phosphorus supply, millet on brown silt loam. All pots received like amounts of lime, nitrogen and potassium, but the phosphorus in the form of bone meal was varied as indicated on the pots. Photographed November 7.

attributed to the different treatment of the pots. It was considered to be due to unknown causes, and the difference was too small to be noted. Two grams, however, was considered to be the limit, and differences greater than two grams were credited to the additional element of plant food which had been added.

From the notes on the growth of the plants, the photographs taken and the yields obtained, the following conclusions have been drawn:

BROWN SILT LOAM.

Wheat Grain

LIME seems to be of some benefit.

NITROGEN produced the largest increase of any of the three elements of plant food added, producing an average increase per pot of 7.5 grams. It produced the largest yield when added at the rate of 800 pounds of dried blood to an acre - 5 grams per pot. This rate produced even more than did heavier applications.

PHOSPHOROUS produced an average increase of 3.85 grams per pot. When added at the rate of 320 pounds of acidulated bone meal to an acre - 2 grams per pot - it produced its largest yield. Pot 4 was badly injured by the mice.

POTASSIUM decreased the yield of grain in wheat at the average rate of 2.35 grams per pot. Applied at the rate of 160 pounds of potassium sulfate to an acre - 1 gram per pot - it produced its largest yield. This yield, however, was but 3.5 grams larger than that of pot 7 in A U series which received no potassium fertilizer at all.

Series B-U, - potassium subseries, millet on brown silt loam. All pots received like amounts of lime, nitrogen and phosphorus, but the potassium in the form of potassium sulfate was varied as indicated on the pots. Photographed November [illegible].

Millet Hay Without The Heads.*

LIME seems to have produced slightly beneficial results.

NITROGEN as in the case of wheat produced the largest increase of any element added, an average increase of 14.3 grams per pot. Added in the largest quantity in which it was added to any pot at the rate of 2400 pounds of dried blood to an acre - 15 grams per pot - it produced its largest yield. When added with all the other fertilizers it more than tripled the yield, while in other cases it considerably more than doubled the yield. See photograph page 35.

PHOSPHORUS was probably of some value, having produced an average increase of .9 grams per pot, although it showed no definite results. At the rate of 640 pounds of acidulated bone meal to an acre - 4 grams per pot - it produced its largest yield. This, however, was but two grams more than the yield produced by pot 2 where the bone meal was added at the rate of but 160 pounds to the acre.

POTASSIUM gave no regularly increasing results, but on the other hand frequently decreased the yield. The average showed a loss of 1.2 grams per pot. The pot receiving no potassium fertilizer whatever produced practically as large a yield as the one receiving the heaviest application. It is true that in series B-U potassium subseries pot 4 produced the largest yield of any pot in the subseries, but this yield - 34 grams - is so out of proportion that the increase is not attributed to the action of the potassium sulfate which had been added.

---

* The heads of the millet were badly mutilated by sparrows so that they were removed and not weighed.

Series A-L, Millet on [illegible] clay loam, showing a marked increase of growth in the soil where nitrogen has been added. Photographed November 4.

BLACK CLAY LOAM.

Wheat Grain

LIME is of no benefit. When added with acidulated bone meal it decreased the yield. This, however, is supposed to be due to the revertion of soluble phosphates into insoluble compounds caused by the action of the lime.

In this soil the elements of plant food ranked in the same order of importance as they did in the brown silt loam, namely, nitrogen, phosphorus and potassium.

NITROGEN produced an average increase of 6.1 grams per pot. Applied at the rate of 1600 pounds of dried blood to an acre - 10 grams per pot - it produced the largest yield.

PHOSPHORUS, according to the data at hand, produced its largest yield when applied at the rate of 640 pounds of acidulated bone meal to an acre - 4 grams per pot. The data, however, is rather incomplete because pot 5 is not considered as being reliable. In the regular A-L series it produced an average increase of 1.5 grams per pot.

POTASSIUM can not be said to be of any value, because the pot which received no potassium fertilizer whatever yielded very nearly as heavily as those that did, and in this case even more than the one which received the heaviest application of potassium sulfate.

Millet Hay Without The Heads.

LIME seems to be of some value particularly when added with fertilizers.

NITROGEN as in the foregoing cases produces the largest in-

Series B-L,- Nitrogen quantities, [illegible]. All pots received like amounts of lime, phosphorus and potassium, but the nitrogen in the form of dried blood was varied as indicated on the pots. Photographed November 5.

increase of any element, an average of 19 grams per pot. When added with all the other fertilizers, it more than tripled the yield, while in other cases it produced differences almost equally as great. Added at the rate of 2400 pounds of dried blood to an acre - 15 grams per pot - it produced its largest yield. See photograph, page 43.

PHOSPHORUS produced an average increase of 2.4 grams per pot. This increase was produced chiefly after nitrogen had been added. Pot 3 produced practically as much as any pot in the subseries. In pot 3 phosphorus was added at the rate of 320 pounds of acidulated bone meal to an acre - 2 grams per pot.

POTASSIUM is of no known benefit. Pot 1, which received potassium sulfate at the rate of 32 pounds to an acre, produced the largest yield. In the regular (A-L) series, potassium produced an average decrease of .3 grams per pot.

FINAL CONCLUSIONS.

For the growing of general farm crops it is indeed questionable whether lime would prove profitable; nitrogen is doubtless of great value, particularly in the growing of millet, for which crop is required about twice the application of dried blood that is required for wheat; phosphorus is of some value in almost all cases, but probably profitable only when the deficiency of nitrogen has been supplied, for in such cases the increase due to phosphorus was always greater than where no nitrogen had been added; potassium can not be said to be of any particular value to either wheat or millet, and to add it to the soils investigated in this work would certainly be an economic loss.

The above results also indicate that the black clay loam, which

Series B-L,- Phosphorus [illegible] [illegible] clay loam. All pots received like amounts of lime, nitrogen, and [illegible] but the phosphorus in the form of bone [illegible] [illegible].

has a very black surface soil three feet deep, is increased in productive capacity by the addition of nitrogen, as much as the brown silt loam.

In rational farming the best method of treating these soils would probably be that of adding nitrogen and organic matter by pasturing leguminous crops or by turning them under green, and by making liberal use of farm manures, to which may have been added some ground phosphate rock or ground steamed bone meal. Whether the elements, lime, phosphorus, and potassium may profitably be added, should be determined by plot experiments. Until it has been proved that any of these elements can be added with profit, it would be considered unwise to add them to the entire area comprising the soils investigated.

[illegible] Potassium nutrition, millet on [illegible] loam. All pots received like amounts of lime, nitrogen and phosphorus, but the potassium in the form of potassium sulfate was varied as indicated on the pots. Photographed September [illegible].

APPENDIX.

Acidity of Pot Culture Soils.

An acidity test of the soils used for pot cultures was made by the method recently adopted by the Illinois Experiment Station. This test showed that the soils were but slightly acid. The upland requires but 222.18 pounds and the lowland but 96.6 pounds of ground lime stone (Ca CO_3), to an acre, to entirely correct the acidity.

Chemical Composition of Fertilizers used in Pot Cultures.

Nitrogen in dried blood 13.33 percent.

Phosphorus in acidulated bone meal 10 percent.

Potassium in potassium sulfate 42.6 percent.